11.1 States of Matter and Kinetic Molecular Theory of Gases

Objective

- **explain** states of matter in terms of intermolecular forces and the motion of
- particles
- **describe** a gas using the kinetic molecular theory
- **communicate** your understanding of the pressure

Key Vocabulary

- kinetic molecular theory of gases
- ideal gas
- Compressibility
- Fluidity
- Atmospheric pressure

Types of Particle Motion

Figure 11.2 This model of a particle depicts vibrational motion—the motion of something as it moves back and forth about a fixed position.

Figure 11.3 This model of a particle depicts rotational motion—the motion of something as it spins on its axis.

Figure 11.4 This model of a particle depicts translational motion—the motion of something that moves freely from one place to another.

Summary of States of Matter

State	Structure/Properties	Motion of particles	Attractive forces
Solid	- crystal lattice - fixed position - fixed volume - incompressible	Vibrational- back and forth motion	Strong -eg. electrostatic forces (eg ionic)
Liquid	- fixed volume - Incompressible - Particles can move past each other (flow)	Vibrational Rotational- spinning	- Weaker eg. Dipole-dipole forces (polar molecules) eg. H bond
Gas	- particles far apart - no fixed volume - compressible	Vibrational, rotational, translational- straight line motion (unless collisions occur) -fast motion- high E_k	- very weak - generally non polar molecules - London dispersion forces (temp dipoles) - Large molecules have more dispersion forces because of large # of atoms (can form more temp dipoles) and therefore tend to be liquids rather than gases

Properties of Gases

1) Gases expand as the temperature increases (much more than water and solid)
2) Gases have very low viscosity (they flow fast, fluidity).
3) Gases have much lower densities than solids or liquids.
4) ALL Gases are miscible (some liquids are miscible yet some are immiscible).

Kinetic Molecular Theory of **IDEAL** Gases

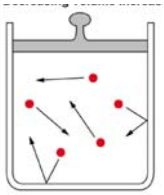
- The volume of an individual gas molecule is negligible compared to the volume of the container
- There are no attractive or repulsive forces between gas molecules
- Gas molecules move randomly in all directions in straight lines
- All gas molecule collisions are perfectly elastic (energy is conserved)
- The average kinetic energy of gas molecules is directly related to the temperature

Phet Simulation

- http://phet.colorado.edu/en/simulation/gas-properties

Factors which influence pressure

1. **Mass of particles**
2. **Speed of particles**
3. **Number of particles**
4. **Volume of container**



Observing atmospheric Pressure in action!

RECALL:
Gas pressure is created by the particles of the gas hitting the container

Pressure is the force exerted over a certain area (P=F/A)

Standard unit of pressure (SI) is the pascal

1pa= $1N/m^2$

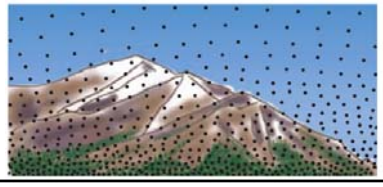
Under PRESSURE!

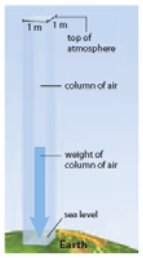
- **Absolute pressure:** Actual pressure exerted by a gas.
- **Relative Pressure:** Pressure exerted by a gas relative to atmospheric pressure (pressure exerted by the gases in the atmosphere).
- **Absolute pressure**: Relative pressure + atmospheric pressure

Unit of pressure	Symbol	Instruments that use the unit
1) Millimetres of Mercury: mm of Hg.	mmHg	Blood pressure meters
2) 1 Torr	torr	Vacuum pumps
3) Pascal (Pa) the SI unit of pressure. 1 kPa = 1000 Pa	Pa	Pressure sensors in pipelines
4) Bars: 1 bar	bar	Pressure sensors in scooba gear
5) Atmospheres (atm)	atm	Gas compressors
6) Pounds per square inch	Psi	Hydraulic pumps

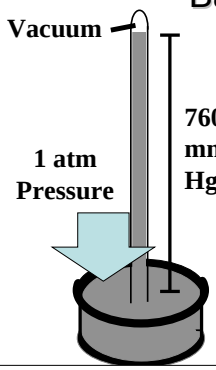
Atmospheric Pressure

- the force exerted on Earth's surface by a
- column of air over a given area
- Fewer gas molecules in air, pressure decreases with altitude
- STP (standard temperature and pressure:
- 0°C and 101.3 kPa





Barometer



- The pressure of the atmosphere at sea level will hold a column of mercury 760 mm Hg.
- 1 atm = 760 mm Hg

Conversion: 1 atm = 760 mm of Hg = 101.325 kPa = 1.01325 bar = 760 torr = 14.7 psi

Real Life Applications

Bags of chips inflate as you drive at higher elevations since there is less external pressure.

As balloons rise in the atmosphere, there is less external pressure. As a result, the balloon inflates more and then pops.

In planes, the airs in your middle ear expands as you rise in altitude. This leaves the feeling of discomfort until your ear pop